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CASE REPORT

Transgraft sac Embolization Combined with Graft Reinforcement for Refractory Mixed-Type Endoleak

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Abstract An 80-year-old female underwent EVAR 4 years ago. She presented type II endoleak with sac expansion from 68 to 80 mm during 3-year follow-up after EVAR. Although she underwent translumbar percutaneous sac embolization, the AAA sac continued to enlarge, suggesting mixed-type endoleak including type I, II, and III. Transgraft direct sac angiography revealed endoleak cavity without demonstrable feeding vessel. Transgraft sac embolization using *n*-butyl cyanoacrylate and graft reinforcement was performed concurrently, without complications. The graft reinforcement consisted of graft extension for eliminating occult type I endoleak, and relining for eliminating occult type III endoleak. Six months after the procedure, CT showed no signs of sac expansion. Transgraft sac embolization combined with graft reinforcement is one of the available options for persistent and refractory mixed-type endoleak.

Keywords Transgraft sac embolization · Mixed-type endoleak · EVAR · *n*-butyl cyanoacrylate · Graft reinforcement

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Introduction

Endoleak is one of the great concerns after endovascular abdominal aortic aneurysm repair (EVAR). Patients who underwent EVAR need lifelong surveillance after EVAR. Secondary intervention after EVAR contributes improving long-term outcome and reducing mortality. Secondary intervention is mandatory for persistent endoleak with continued sac expansion because of the potential risk of rupture [1–3]. Various approaches to the management of type II endoleak have been described, including transcatheter arterial embolization and percutaneous embolization by direct sac puncture [2–4].

Most of simple type endoleak can be easily identified on follow-up diagnostic imaging such as CT, MRI, and ultrasound. However, in some patients where complex endoleaks exist involving more than two types, it is

difficult to identify or differentiate the type of endoleak precisely, and the difficulty of identifying the source can lead to a diagnostic and therapeutic dilemma. The later type of endoleaks may be refractory to percutaneous treatments.

We report a case of successful treatment with transgraft sac embolization combined with graft reinforcement for a patient with mixed-type endoleak refractory to translumbar percutaneous direct sac embolization.

Case Report

Our Institutional Review Board approved the preparation of this report. Patient consent for publication was obtained for this case report. An 80-year-old female with a history of hypertension, brain infarction, chronic heart failure, and right nephrectomy on long-term antiplatelet and antihypertensive therapy was treated with EVAR at our institution 4 years ago. She underwent EVAR for abdominal aortic aneurysm (AAA) using Endurant® AAA stent-graft system (Medtronic, Inc., Minneapolis, MN, USA). She presented persistent endoleak with sac expansion from 68 to 80 mm during 3-year follow-up after EVAR. She eventually underwent a translumbar percutaneous direct sac embolization with *n*-butyl cyanoacrylate (NBCA) (B.Braun, Melsungen, Germany) mixed with Lipiodol (Guerbet, Villepinte, France) and metallic coils for the endoleak 3 years after EVAR (Fig. 1a). She was followed up after embolization by plain CT due to renal poor function. Plain CT 1 year after translumbar embolization revealed sac expansion from 80 to 86 mm with wash out of Lipiodol from the sac and migration of intra-sac coils to downward (Fig. 1b). In view of the imaging findings of sac expansion, Lipiodol washout, and coil migration, the endoleak was suggested as a mixed-type (including type I, II and III). After a multidisciplinary discussion, a transgraft sac embolization combined with graft reinforcement was planned. The procedure and outcomes were discussed with the patient, and an informed consent was obtained.

The procedure was performed under local anesthesia in the interventional radiology (IR) suite equipped with an IR-CT system, comprising digital subtraction angiography (Infinix Celeve™-I; Toshiba Medical Systems Corporation, Tochigi, Japan) and 64-multislice CT (Aquilion™ CX; Toshiba). Femoral artery (FA) was surgically exposed, and a 16-Fr sheath (W. L. Gore & Associates, Inc., Flagstaff, AZ, USA) was inserted into the right FA. Aortography showed no apparent type I or III endoleak. 10-Fr Rösch-Uchida transjugular liver access set (RUTLAS) (Cook Medical Inc., Bloomington, IN, USA) was inserted from the right FA. The AAA sac was directly punctured from inside of stent-graft using 0.038-inch trocar stylet needle under fluoroscopic guidance. The needle was steadily advanced into the sac with the needle position checked under fluoroscopy. A single puncture was performed. After puncture, needle was withdrawn and 0.035-inch guidewire (Terumo Co., Ltd., Tokyo, Japan) was inserted into the sac through the trocar (Fig. 2a). The trocar was exchanged to 4-Fr catheter (Terumo Co.). Successful insertion of the catheter within the endoleak cavity was confirmed with manual check angiography. Transgraft direct sac angiography revealed endoleak cavity without any demonstrable feeding vessel such as lumbar artery (LA) or inferior mesenteric artery (IMA) (Fig. 2b).

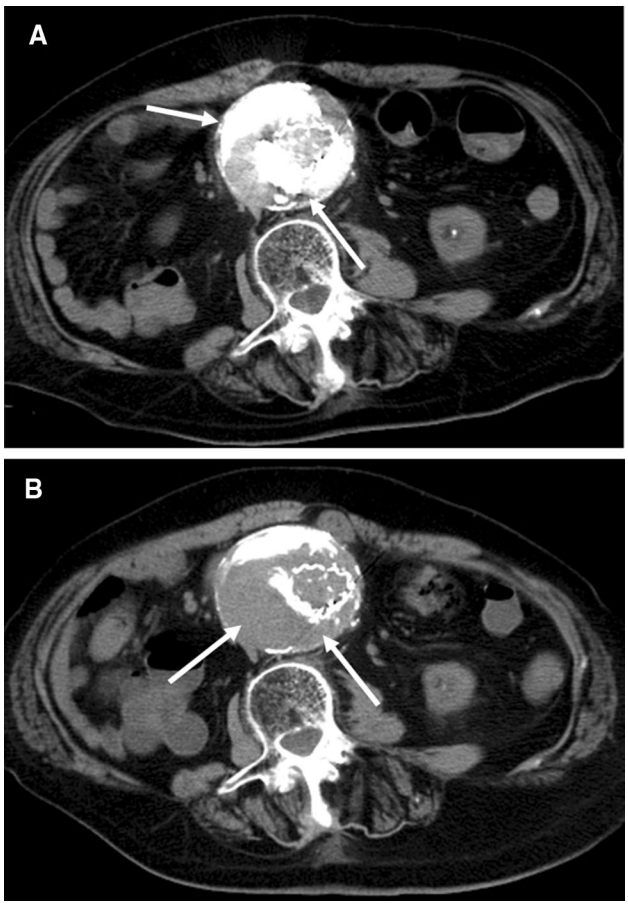
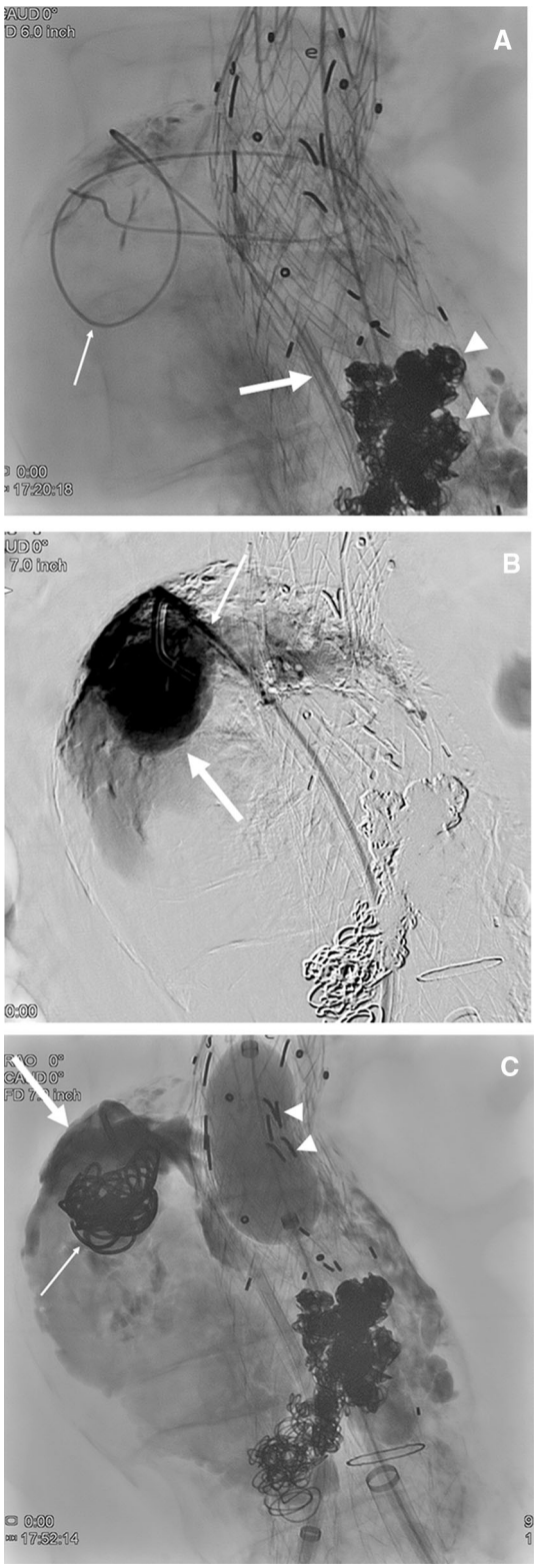


Fig. 1 An 80-year-old female 48 months after EVAR with an Endurant® AAA stent-graft system. **A** CT 1 week after translumbar percutaneous direct sac embolization, CT revealed Lipiodol accumulation in the sac (white arrows). **B** CT 1 year after translumbar percutaneous direct sac embolization, CT revealed sac expansion and wash out of Lipiodol from the sac (white arrows)

The procedure was performed in multiple steps. First, the endoleak cavity was embolized using metallic coils (AZUR-CX®; Terumo Co.). Next, with the catheter still within the endoleak sac, an aortic cuff (Excluder®; W. L. Gore & Associates, Inc., Flagstaff, AZ, USA) was inserted via the contralateral femoral artery and deployed into the main body for covering the needle hole. NBCA



◀**Fig. 2** Transgraft sac embolization and graft reinforcement procedure. **A** Fluoroscopic image obtained after transgraft sac puncture 10-Fr Rösch-Uchida transjugular liver access set (thick white arrow) was inserted from the right femoral artery. The AAA sac was directly punctured from inside of the stent-graft using 0.038-inch trocar stylet needle under fluoroscopic guidance. The needle was steadily advanced into the sac with the needle position checked. After puncture, needle was withdrawn and 0.035-inch guidewire was inserted into the sac (thin white arrow). Migration of intra-sac coils to downward was recognized (white arrow heads) (used at the time of translumbar sac embolization). **B** Transgraft direct sac angiography Transgraft direct sac angiography revealed endoleak cavity (thick white arrow) without any demonstrable feeding vessel such as lumbar artery or inferior mesenteric artery. (thin white arrow: 4-Fr catheter). **C** Image taken during transgraft sac embolization and graft reinforcement. First, endoleak cavity was embolized using metallic coils (thin white arrow). Next, the aortic cuff (white arrow heads) was inserted and deployed into the main body for covering the needle hole. NBCA-Lipiodol (thick white arrow) was injected under balloon inflation to prevent the NBCA reflux into the stent-graft. The sac was completely filled and embolized with NBCA-Lipiodol (total injected volume, 15 mL). After sac embolization, graft extension and relining were performed

was mixed with Lipiodol at a ratio of 1:4. NBCA-Lipiodol was injected through the catheter into the sac, while a balloon was inflated in the aortic cuff to prevent the reflux of NBCA-Lipiodol into the stent-graft. The sac was completely filled and embolized with NBCA-Lipiodol (total injected volume, 15 mL) (Fig. 2c). Following the removal of the catheter, the balloon was expanded once again to close any dead space between the two overlapping stent-grafts.

Finally graft reinforcement was performed. Graft reinforcement consisted of graft extension and relining. Aortic cuff (Excluder®) was deployed in the proximal neck to eliminate occult type Ia endoleak. Next, limb extensions (AFX®; 20 mm diameter, 55 mm length, Endologix Inc., Irvine, California, USA) were deployed in parallel from the flow divider into both limbs using "kissing endograft" technique to eliminate occult type III endoleak. This was then followed with leg extensions (Excluder®) that were deployed in the distal neck bilaterally to eliminate occult type Ib endoleak (Fig. 3). There were no procedure-related complications. Six months after the procedure, the patient shows no radiological signs of AAA sac expansion (Fig. 4).

Discussion

Endoleak is defined as persistent flow into the aneurysmal sac from different sources. Type I endoleak is characterized by arterial blood flow into the aneurysm sac from the proximal or distal attachment site of the stent-graft as a result of inadequate fixation, hostile neck or shortening of

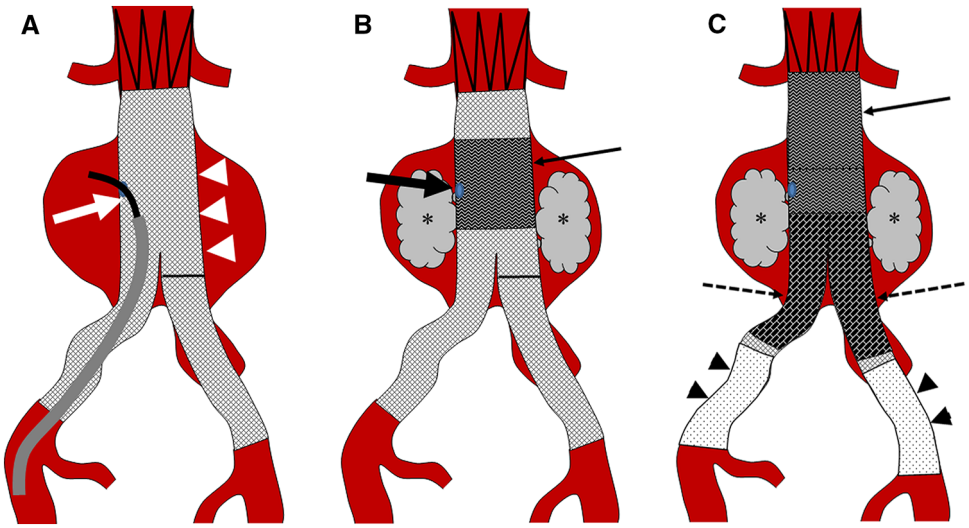


Fig. 3 Schema of this technique. **A** Schema shows transgraft sac puncture by 10-Fr Rösch-Uchida transjugular liver access set (thick white arrow) (white arrow heads: Endurant® AAA stent-graft system), **B** Schema shows the aortic cuff (Excluder®) (thin black arrow) deployment into the main body for covering the needle hole (thick black arrow). (*: NBCA-Lipiodol), **C** Schema shows graft reinforcement after transgraft sac embolization. Aortic cuff (Excluder®) was deployed in the proximal neck to eliminate occult type Ia endoleak (thin black arrow). Next, limb extensions (AFX®) were deployed in parallel from the flow divider into both limbs using "kissing endograft" technique to eliminate occult type III endoleak (thin dotted black arrow). And then the leg extensions (Excluder®) were deployed in distal neck bilaterally to eliminate occult type Ib endoleak (black arrow heads)

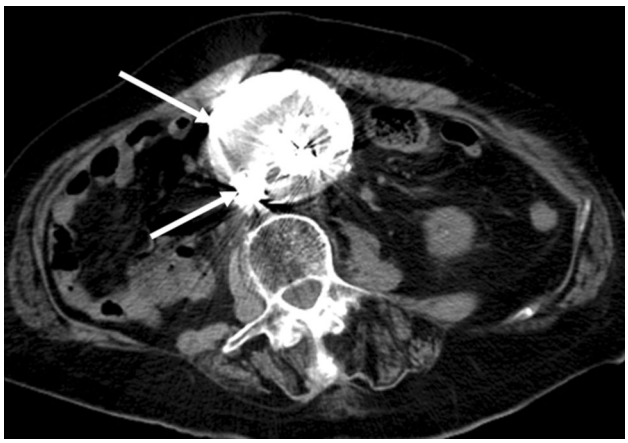


Fig. 4 Plain CT 6 months after transgraft sac embolization and graft reinforcement. The sac was stable. Lipiodol accumulation and coils were visualized (white arrows)

proximal neck. Type II endoleak, the most common type, is characterized by blood flow in a retrograde manner into the aneurysmal sac through patent branch vessels of the abdominal aorta, such as LA or IMA. Type III endoleak is characterized by blood leak from a modular disconnection or graft fabric tear. Type III endoleak can be caused by several causes, such as repeated endovascular manipulations, aortic ballooning, thread hole of stent suture, and manufacturing defects [5]. Direct sac embolization is effective for type II endoleak, but not effective for type I nor III endoleak. Graft extension can eliminate type I endoleak, and graft relining can eliminate type III endoleak [6]. Although our patient was previously treated by translumbar percutaneous direct sac embolization, the sac continued to enlarge. This persistent endoleak refractory to embolization suggested a mixed-type endoleak including type I, II, and III endoleak. The combined or mixed-type endoleak is rare according to the current studies [7–9]. Mixed-type endoleaks pose a diagnostic dilemma because of difficulty to identify and differentiate their sources using routine imaging techniques, thereby making them more challenging to treat. Theodoridis et al. reported combined type III and II endoleaks. They performed transcatheter arterial embolization for the type II endoleak which has been visualized apparently after eliminating type III endoleak [8]. When more than two different type endoleaks exist in the sac in a mixed manner, low flow endoleak and its responsible arteries are manifested visibly after the dominant high flow endoleak is eliminated.

We performed transgraft sac embolization combined with graft reinforcement. The most significant advantage of this procedure is to eliminate simultaneously type I, II, and III endoleak including the occult type of endoleak most often interpreted as endotension. This also contributes to the hemodynamic stability of the sac. Transgraft sac embolization is not associated with risks of retroperitoneal or intra-abdominal bleeding, bowel injury, and vessel injury, unlike percutaneous direct sac embolization [4, 5]. However, to prevent iatrogenic type III endoleak by graft puncture, covering the needle hole by the aortic cuff is an essential step. The tips and tricks of this procedure are to

analyze the aneurysm sac and endoleak in detail by CT before puncture and to plan the puncture point in the stent-graft and entry direction into the sac. The needle position needs to be carefully followed and confirmed using different fluoroscopic views when the needle is advanced into the sac.

We used RUTLAS for transgraft sac puncture. This RUTLAS allows for the insertion of a 4-Fr catheter into the sac through the device. The advantage of using this system is the ability to inject sufficient NBCA directly into the sac and easy of deploying large coils. Mewissen MW et al. reported transgraft sac embolization using a coronary laser catheter with Onyx (LES, Covidien, Plymouth, MN, USA) [10]. However, the coronary laser catheter limits the operator to insertion of only microcatheter into the sac through the device. This makes it difficult to inject large quantities of liquid embolic agents into the sac.

In this case, the patient had an Endurant® stent-graft with a fabric made of polyester which was easy to penetrate. The stent-grafts covered with e-PTFE or Dacron might pose as a limitation to this technique as penetration of these fabrics and insertion of a 4-Fr catheter might not be easy.

In conclusion, transgraft sac embolization combined with graft reinforcement can be considered as a therapeutic option for persistent and refractory mixed-type endoleak.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Consent for Publication Consent for publication was obtained for person's data included in the study.

Human and Animal Participants This procedure performed in study involving human participant was in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from the participant included in the study.

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